

*CATHODE FOR A DIRECT METHANOL FUEL CELL AND METHOD FOR OPERATING
SAME*

CROSS REFERENCE TO RELATED APPLICATIONS

This application is the US national phase of PCT
5 application PCT/DE2004/000735, filed 8 April 2004, published 28
October 2004 as WO 2004/093225, and claiming the priority of
German patent application 10317780.9 itself filed 16 April 2003,
whose entire disclosures are herewith incorporated by reference.

FIELD OF THE INVENTION

10 The invention relates to a cathode for a low-
temperature fuel cell, especially for a direct methanol fuel
cell, and to an advantageous method of operating [[the]] same.

BACKGROUND OF THE INVENTION

15 A low-temperature fuel cell, especially a polymer-
electrolyte-membrane (PEM) fuel cell is comprised of an anode and
a cathode which are separated by a polymer membrane which is
permeable for ions. This electrolyte is about 0.1 mm thick. The
gas-tight membrane, which is impermeable for hydrogen and oxygen
and is also not conductive with respect to electrons is as a rule
20 permeable to protons. The catalyst layer contains as a rule
platinum or platinum alloys and is arranged as a thin
catalytically effective member on the membrane. The electrodes
have a high porosity and thus a large surface area which is
advantageous for the electrochemical reactions which are to be
25 carried out thereon.

The electronically conducting diffusion layer of the electrode is connected with the current collector and bounded directly on the catalyst layer.

Through the so-called bipolar plates, the individual
5 cells are separated from one another on the one hand and serve to feed the operating media, fuel and oxidizing agent, on the other, on the other. With the aid of suitable distributor structures, the operating media are uniformly fed homogeneously to the electrodes.

10 The hydrogen supplied to the anode reacts electrochemically at the anode with the aid of the catalyst. The electrons which are thereby liberated travel through the current collector to the external electric current circuit while the protons diffuse through the electrolyte membrane to the cathode.
15 The negatively charged electrolyte ions conduct the protons further although the ions themselves remain locally fixed. At the catalyst layer of the cathode the oxygen ions from the air recombine with the electrons from the external electric circuit and protons from the membrane and produce water with the
20 development of heat. The membrane at the anode side is maintained uniformly moist while at the cathode side the product water generally must be removed.

With the low-temperature fuel cells known from the state of the art, a problem arises in that the diffusion layer of
25 the cathode tends to be plugged or flooded by permeating water or water generated at the cathode so that a frictionless oxygen transport to the catalyst layer of the cathode can no longer occur. As a consequence, these fuel cells must generally be operated with a high excess of oxygen so as to reduce the
30 [[afore]] above-described transport problems for the oxygen.

OBJECT OF THE INVENTION AND SOLUTION

The object of the invention is to provide a fuel cell in which the aforementioned mass transport blockages and problems and of flooding or plugging the cathode with permeating and produced water can be prevented or obviated. ~~The objects of the invention are achieved with a fuel cell with the totality of the features of the main claim as well as with a method of operating this fuel cell according to the auxiliary claim. Advantageous features of the fuel cell and the method are found in the claims respectively dependent thereon.~~

SUMMARY SUBJECT OF THE INVENTION

The underlying concept of the invention is based upon the fact that the oxygen required at the cathode need not be fed first through the porous layer (diffusion layer) of the cathode to the catalyst layer since this as a rule can be plugged or flooded by water which creates a mass transport problem for the diffusing oxygen.

Rather, to solve this problem, the invention provides a fuel cell with a cathode which comprises a diffusion layer with the catalyst layer arranged thereon and in which the diffusion layer directly bounds the ion conducting membrane and the free cathode space turned toward the side of the catalyst layer has the oxygen fed directly thereto.

In principle this results in a replacement of the usual arrangement of the layers of a cathode within a fuel cell as has been the case up to now. Since with the cathode according to the invention in the diffusion layer apart from the electron transport also as ion transport occurs, the diffusion layer is an

ion conducting material. Especially the diffusion layer has a high proportion of an ionomer phase.

With the cathode according to the invention the gaseous oxygen is advantageously fed directly onto the catalyst layer optionally through a distributor structure. The protons travel from the anode through the electrolyte membrane and then through the diffusion layer of the cathode which is both electron and ion conductive, to the catalyst layer where the electrochemical reaction occurs. The electrons are transported by the current conductor also through the electron conducting diffusion layer of the cathode to the catalyst layer. The water filled or plugged (flooded) diffusion layer is then advantageously no longer a transport barrier for the oxygen. Simultaneously the water which is produced at the catalyst layer can easily be conducted into the free cathode compartment and need no longer pass first through the diffusion layer as is the case with the state of the art.

The fuel cells according to the invention and the method of operating such a fuel cell have the following advantages with respect to the state of the art:

The catalyst layer can be supplied with oxygen in a simple manner without material transport barriers to the oxygen transport.

The water formed at the catalyst layer can together with permeating water be easily discharged through the cathode compartment since it can directly flow off into the free cathode compartment and need no longer travel through a porous material.

SPECIFIC ~~SPECIAL~~ DESCRIPTION [[PART]]

In the following, the subject matter of the invention is described based upon two figures and an example in greater detail without limiting the scope of the invention thereby.

Legends for the figures:

- 5 1. Ion conducting electrolyte membrane
2. Anode:
 - 2a. Electrically conducting diffusion layer
 - 2b. Catalyst layer
 - 2c. Free anode compartment, optionally with
 - 10 distributor structure.
3. Cathode:
 - 3a. Electrically conducting diffusion layer.
 - 3b. Catalyst layer.
 - 3c. Free cathode department, optionally with
 - 15 distributor structure.
4. Current collector.

FIG. 1 shows schematically the structure of a fuel cell according to the state of the art in which the catalyst layer of the cathode bounds directly on the electrolyte membrane.

- 20 By contrast FIG. 2 shows an embodiment according to the invention of a fuel cell with a cathode 3 whose diffusion layer 3a directly bounds on the electrolyte membrane 1 and the catalyst layer 3b is open to the free cathode compartment 3c.